

# Update on the BNL VLBL Study

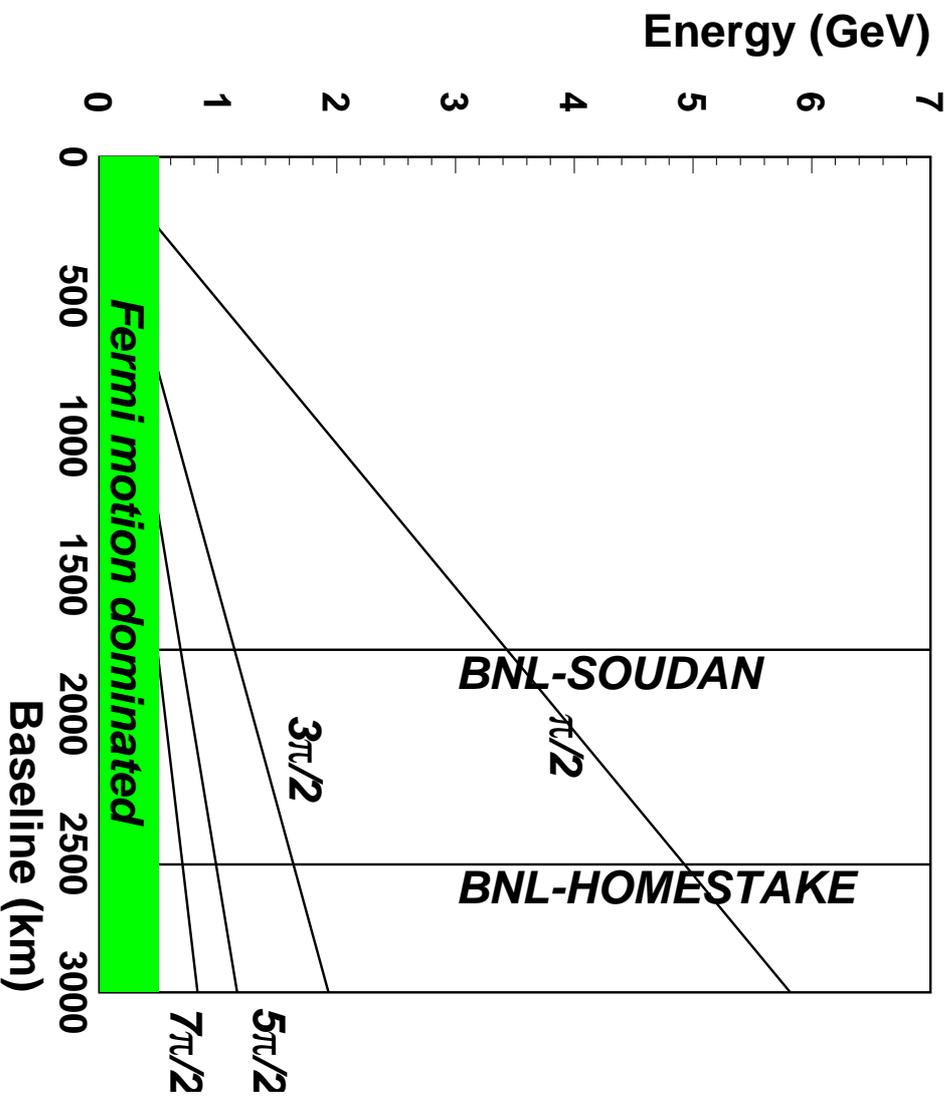
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- Brief introduction to the BNL VLBL concept
- Primary and secondary beam
  - Summary of “baseline” primary beam design
  - New ideas for improvements
- Direction Sensitive photo-Sensor work

### Oscillation Nodes for $\Delta m^2 = 0.0024 \text{ eV}^2$

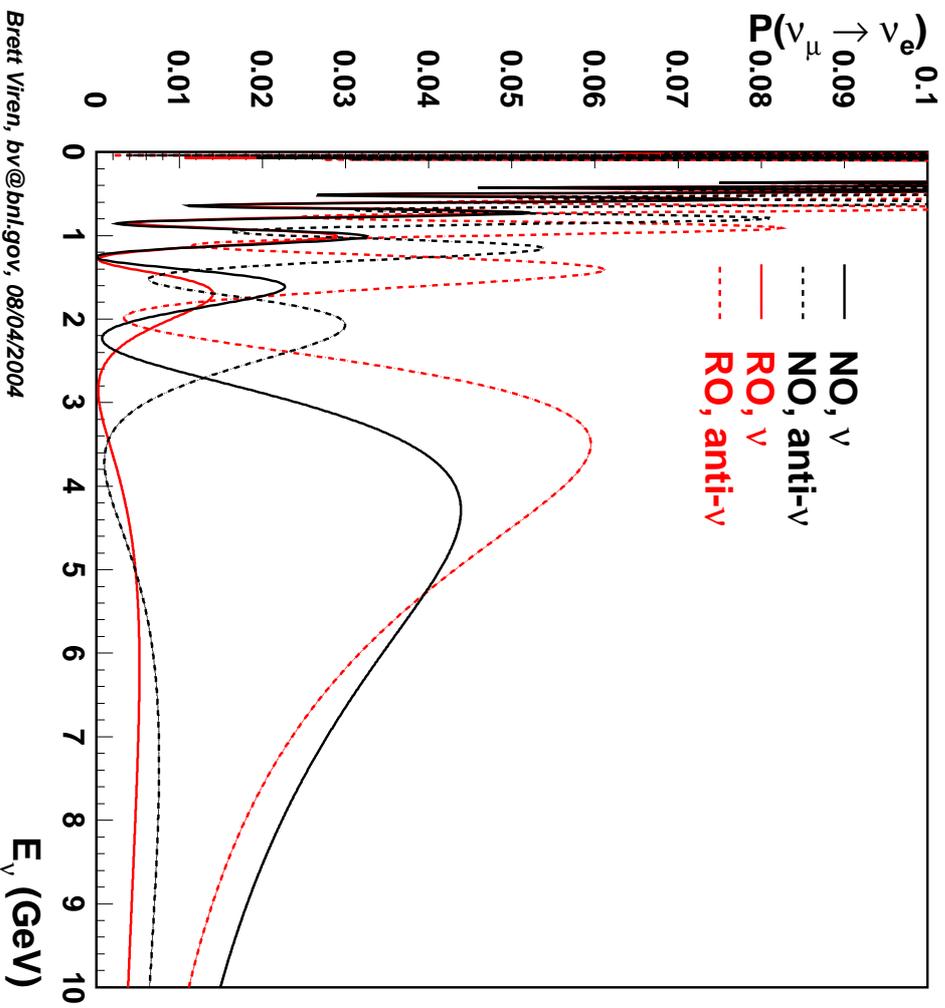


With very long baselines:

- Multiple oscillations visible, increased resolution, decreased normalization systematics
- Osc. at energies where:
  - Cross sections are higher
  - Fermi motion less dominant
  - Different physics at different energies
- SK says, need  $> 2000 \text{ km}$

Need wide band, high energy  $\nu$  beam and a long baseline  $\longrightarrow$

## Mass hierarchy

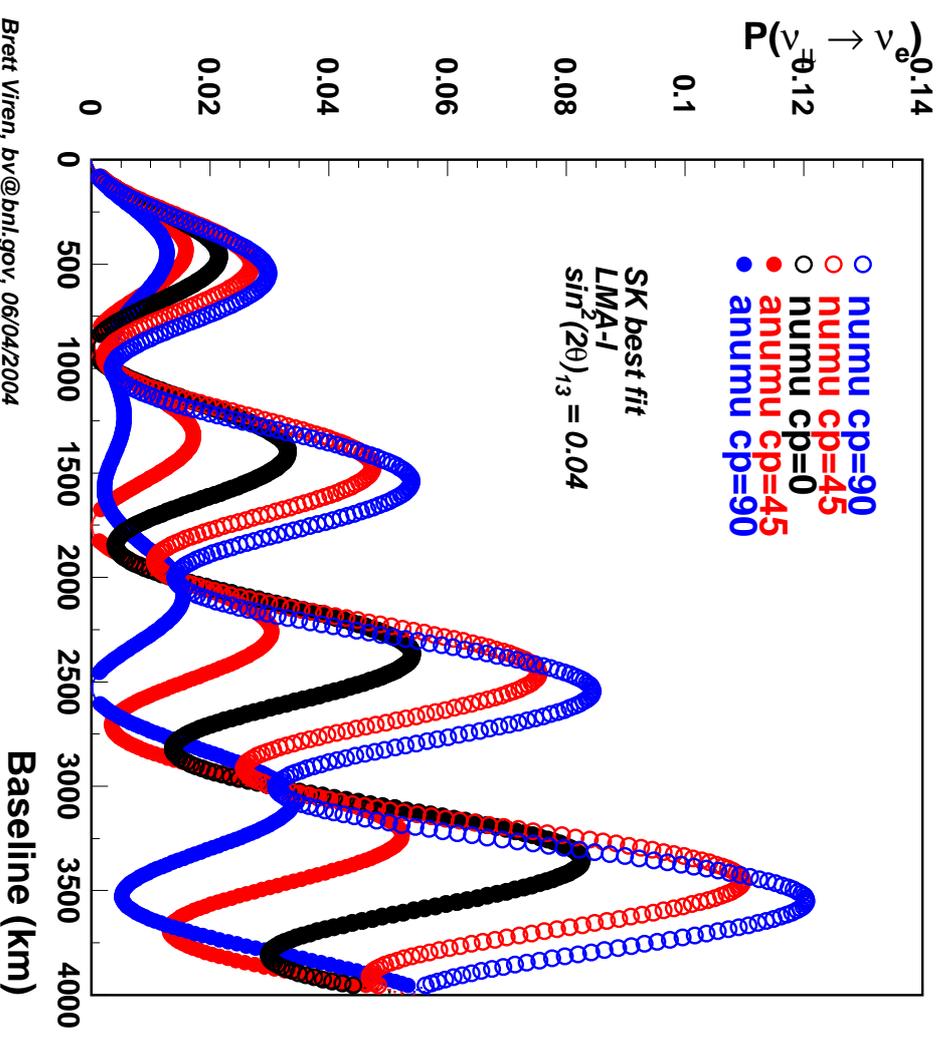


Brett Viren, bv@bnl.gov, 08/04/2004

With a very long baseline:

- Large enhancement of  $\nu_e$  appearance in first oscillation due to matter effect
- $\text{sign}(\Delta m^2)$  easy to measure

## 1 GeV neutrino, vacuum



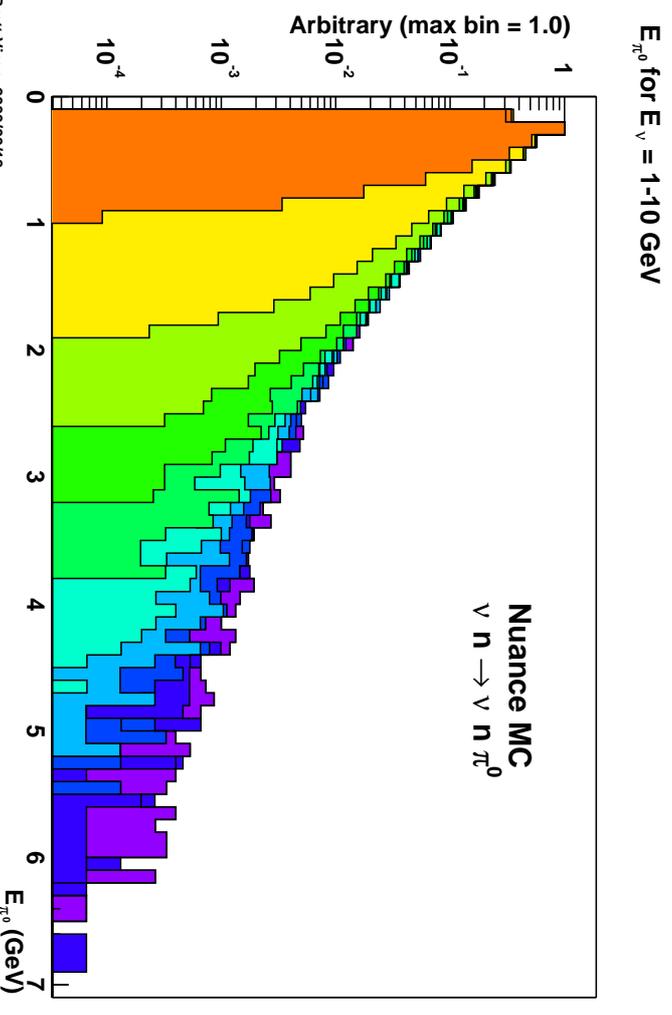
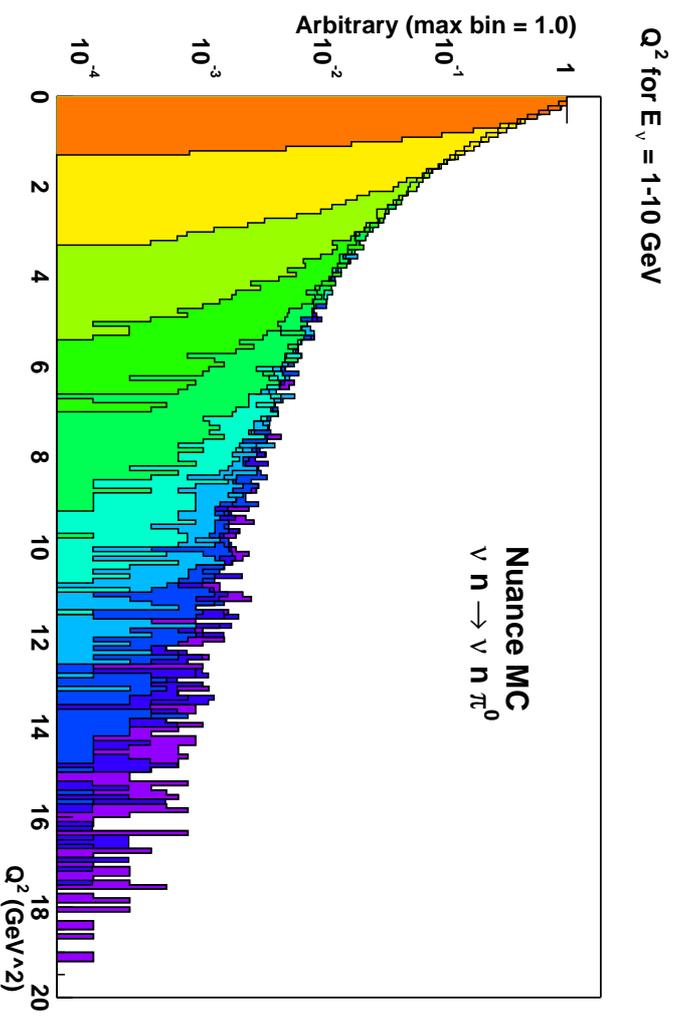
Brett Viren, bv@bnl.gov, 06/04/2004

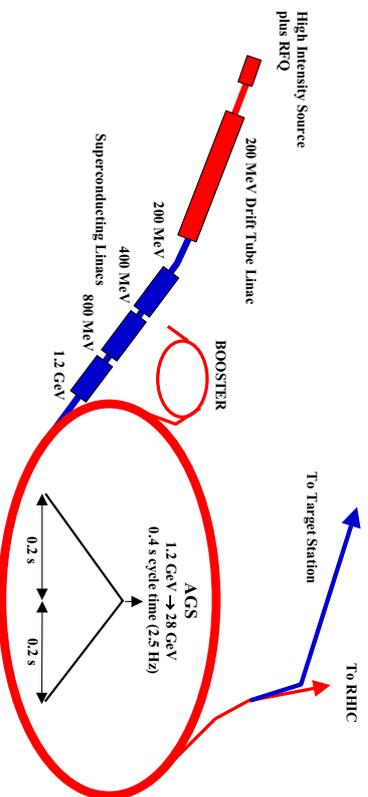
Marciano (hep-ph/0108181):

- Flux goes as  $1/L^2$
- CPV grows w/  $L$
- FOM =  $A^2 N_{\nu} / (1-A^2)$

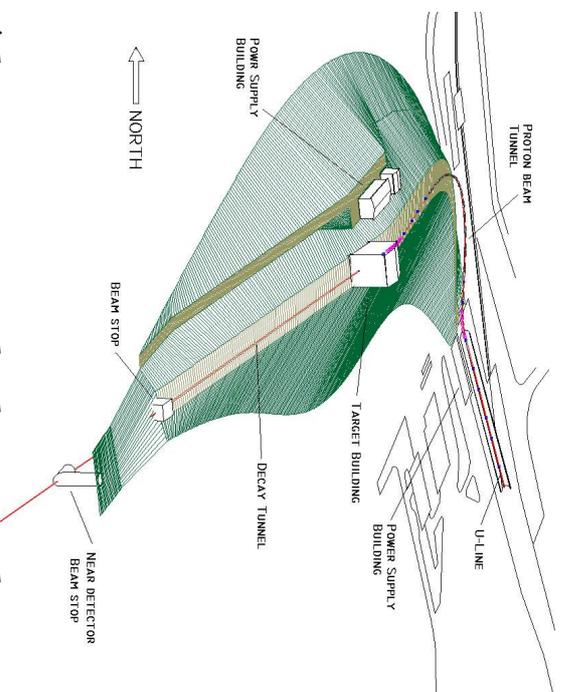
CPV FOM ~independent of baseline for same beam power and detector mass

- $Q_2$  (top) and  $E_\tau$  (bottom) for single- $\pi^0$  NC events
- Each color band: mono-energetic neutrinos 1-10 GeV in 1 GeV steps
- Pileup below 2 GeV a major difficulty
- Above 2 GeV, > 50x suppression, naturally

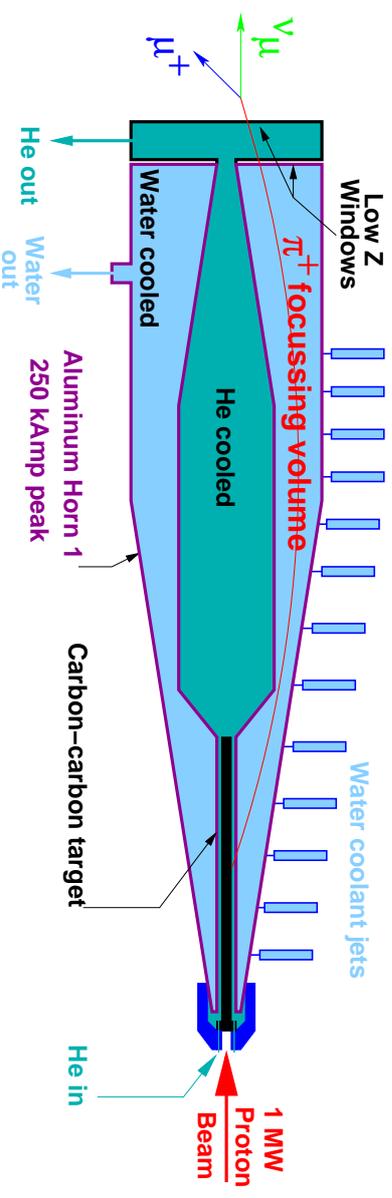




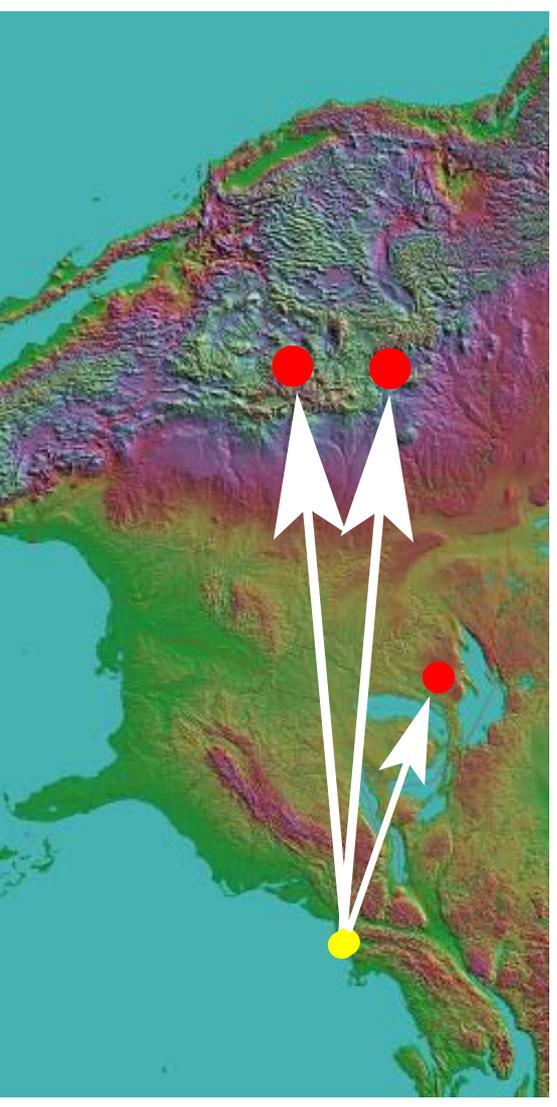
Upgrade AGS to 1 MW, 28 GeV. 5 years of  $1e7$  seconds running.



Above ground decay channel - The Hill



80 cm x 6 mm carbon-carbon target, He and H<sub>2</sub>O cooled, conventional 2 horn focus.



2000+ km baseline to 500 kTon fiducial WC detector.

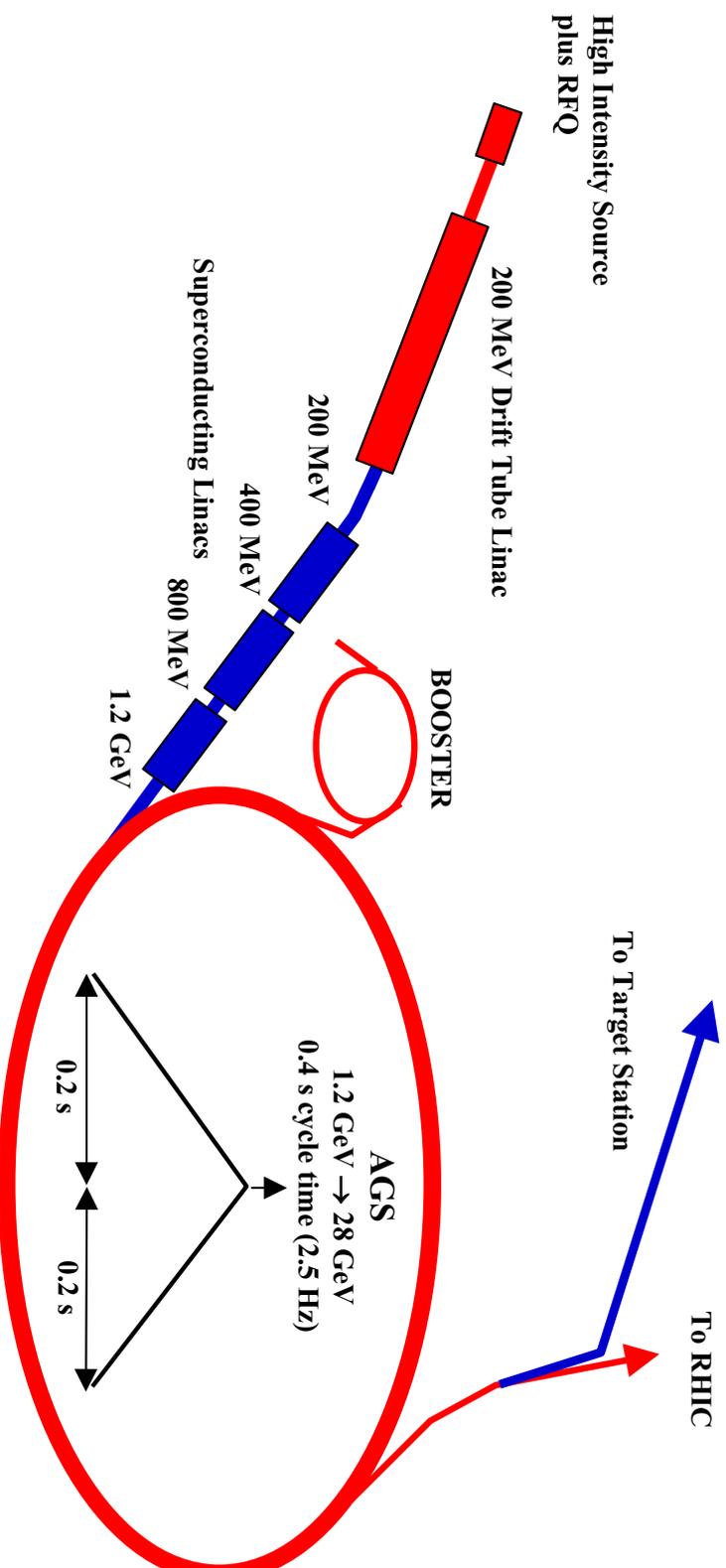
### Costs:

- Bottom-up estimate, FY04 dollars
- Direct cost \$273.4M direct
- Total (30% contingency, 14.5% BNL overhead) \$406.9M

### Schedule:

- 3 years R&D
- Construction starts 1 year after R&D starts
- 4.5 years construction, 0.5 year commissioning
- Utilize RHIC shutdown periods work involving existing machines

Based on RHIC and SNS ring and LHC magnet construction



- Existing 200 MeV room temperature Linac
- New 0.2-1.2 GeV superconducting Linac with 0.8/1.6/1.6 GeV sections

Modifications:

- Upgrade 200 MeV Room Temp DTL to 400 MeV copying the same FNAL 1993 upgrade
- SCL 1.2 GeV w/ 0.8/1.6/1.6 GHz sections to 1.5 GeV all at 0.8 GHz.

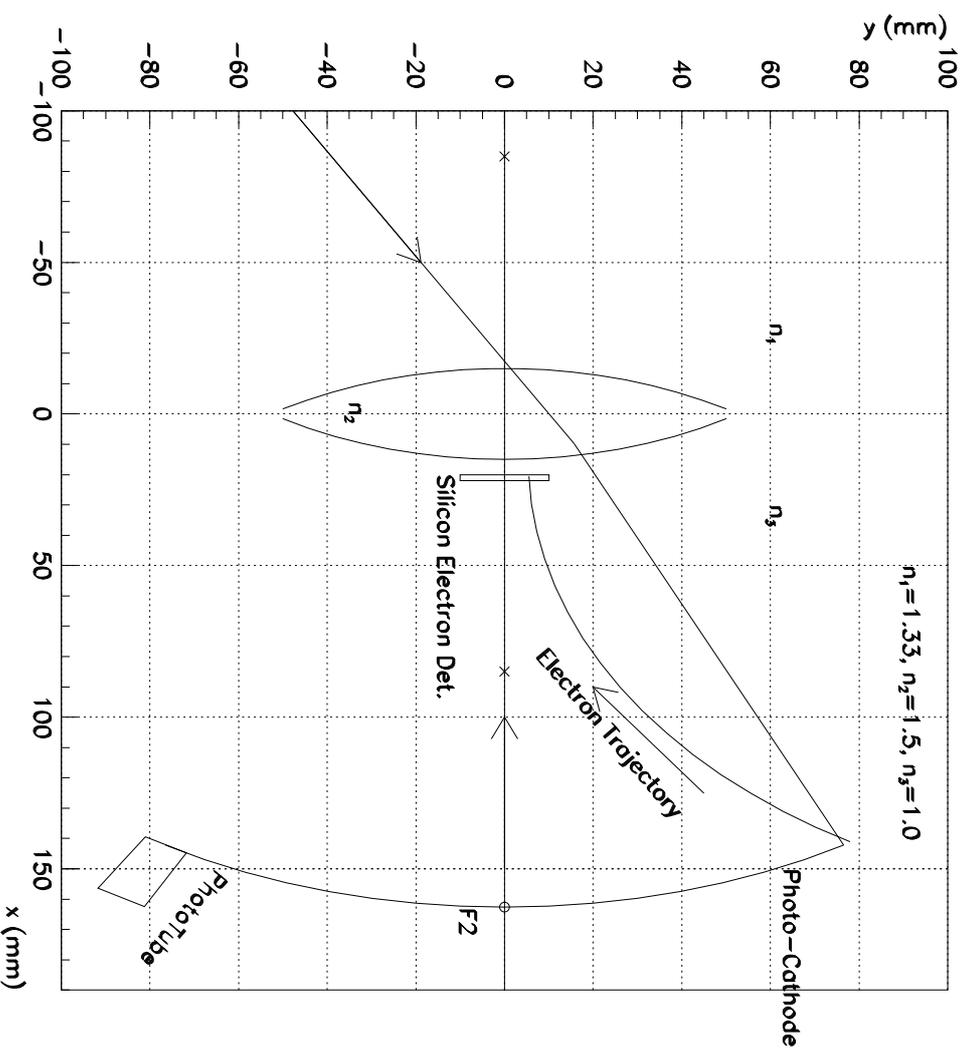
This gives:

- Use more proven, reliable technology
- Less R&D needed, get better performance
- The 1.5 GeV injection leaves the door open for **2 MW running**
  - Space charge effect lessened, less losses at injection
  - Would still need double the motor-generator power supplies
  - Would need new, redesigned AGS cavities



The idea:

- Record photon direction as well as time may give improved  $e/\pi^0$  separation.
- Use lens to convert direction to position
- Read out light either by array of PMTs, or hybrid of reflection photocathode and photoelectron steering onto a silicon readout

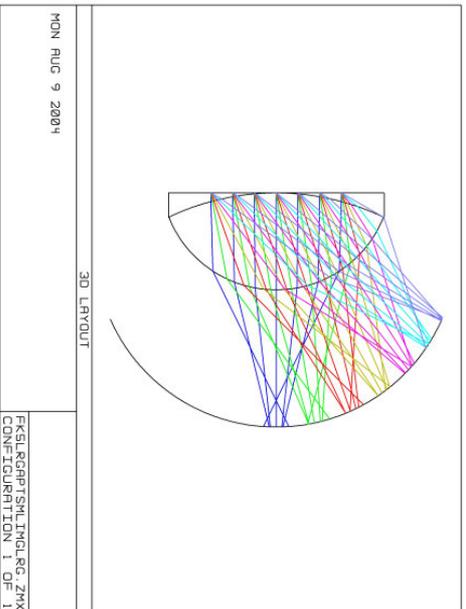
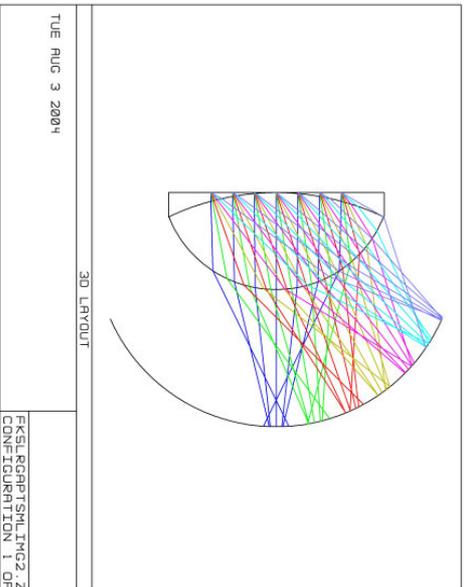
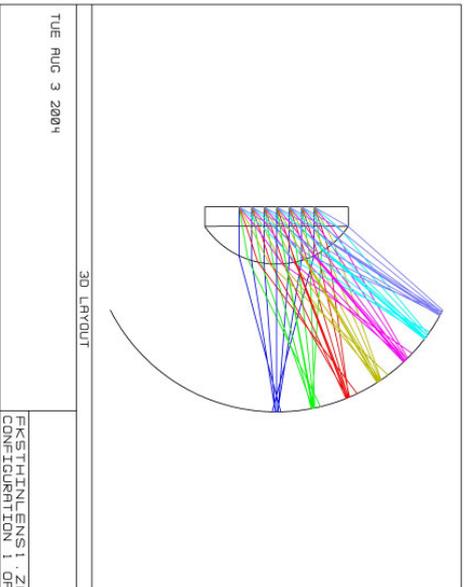
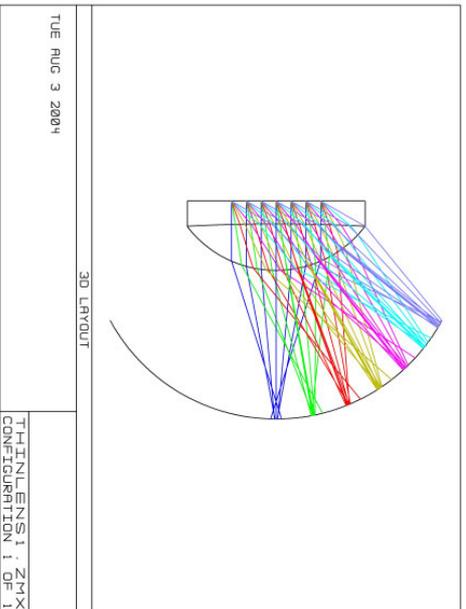
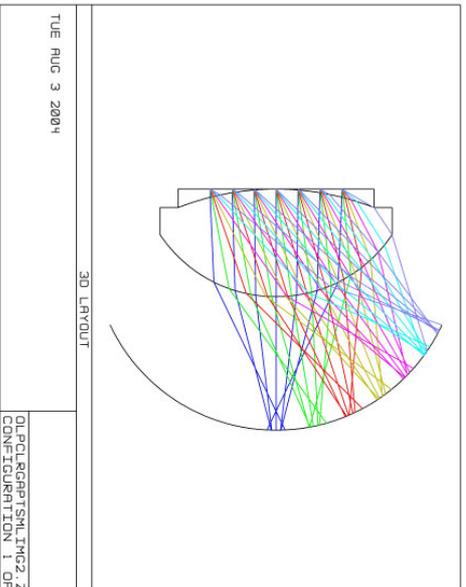
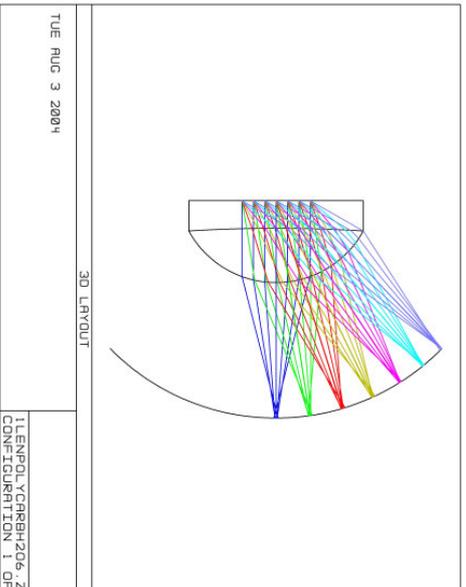


Work most recently done by BNL summer student Zach Parsons of University of South Dakota.

Optimize on:

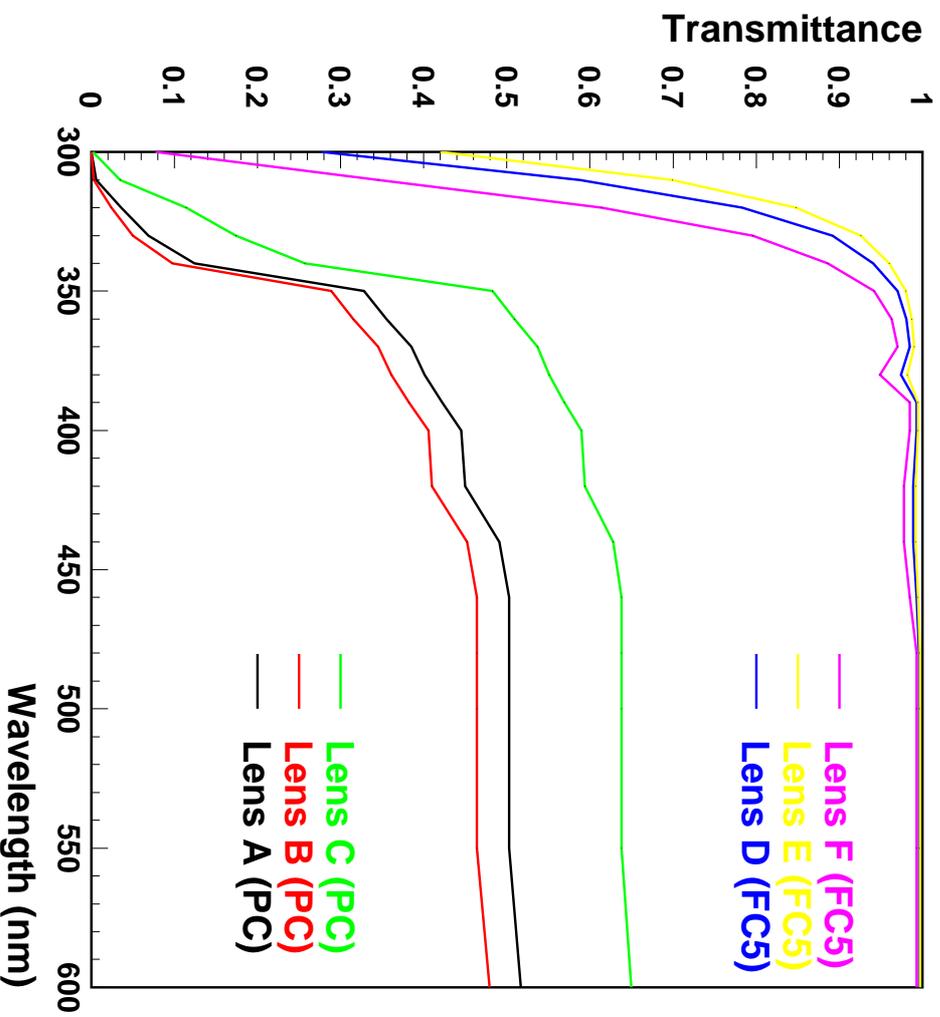
- $\Downarrow$  Complexity
- $\Downarrow$  Angular resolution = spot size / focal plane radius
- $\Downarrow$  Surface area of image plane
- $\Uparrow$  Ratio of aperture to total lens diameter
- $\Downarrow$  Absorption (via thickness and/or material)

Used “ZEMAX” program





## Lens Transmittance (normal incidence)



- FC5 is a special high transmittance glass.
- PC is simple polycarbonate

Still to do is put these into UNO MC and test for reconstruction improvements

## **AGS Super Neutrino Beam Facility Report**

[http://raparia.sns.bnl.gov/nwg\\_ad/and](http://raparia.sns.bnl.gov/nwg_ad/and)

<http://nwg.phy.bnl.gov/preprints.php>